

Claims

What is claimed is:

1. A horizontal drilling system comprising:

a horizontal drilling machine, comprising:

a drill string having a first end and a second end;

a drive system operatively connectable to the first end of the drill string

5 and adapted to advance the drill string through the earth; and

a downhole tool connectable to the second end of the drill string; and

a machine control system adapted to operate the drilling machine, the machine  
control system comprising:

a plurality of sensors, each sensor positioned to sense data relative to at  
least one of a plurality of parameters defining the operation of the  
drilling machine; and

a main control circuit adapted to receive data from the plurality of sensors  
and to automatically operate the drilling machine in response to the  
data.

2. The drilling system of claim 1 wherein:

the horizontal drilling machine further comprises a pipe handling system adapted  
to extend the drill string;

the plurality of sensors comprises a pipe handling sensor group comprising a  
selected set of the plurality of sensors; and

the main control circuit comprises pipe handling control circuitry adapted to  
receive data from the pipe handling sensor group and to automatically  
operate the pipe handling system.

3. The drilling system of claim 2 wherein the drill string comprises a plurality of pipe sections connectable at threaded pipe joints.

4. The drilling system of claim 3 wherein:

1020 the pipe handling system comprises:

103 a pipe handling assembly adapted to transport pipe sections to and from a connection area; and  
5 a drill string length modification assembly adapted to make up and break out the drill string;

the pipe handling sensor group comprises a pipe handling assembly sensor group and a drill string length modification sensor group; and

the pipe handling control circuitry comprises:

40 handling assembly circuitry to receive data from the pipe handling assembly sensor group and to automatically operate the pipe handling assembly; and

45 drill string length modification circuitry to receive data from the drill string length modification assembly sensor group and to automatically operate the drill string length modification assembly.

5. The drilling system of claim 4 wherein:

the pipe handling system further comprises a pipe lubrication assembly adapted to lubricate selected pipe joints;

5 the pipe handling sensor group further comprises a pipe lubrication assembly sensor group; and

the pipe handling control circuit further comprises pipe lubrication control circuitry adapted to receive data from the pipe lubrication assembly sensor group and to automatically operate the pipe lubrication assembly.

6. The drilling system of claim 1 wherein:

the horizontal drilling machine further comprises a fluid dispensing system adapted to pump fluid through the drill string to the downhole tool;

the plurality of sensors comprises a fluid dispensing system sensor group comprising a selected set of the plurality of sensors; and

the main control circuit comprises fluid dispensing control circuitry adapted to receive data from the fluid dispensing sensor group and to automatically operate the fluid dispensing system.

7. The drilling system of claim 1 wherein:

the plurality of sensors comprises a guidance control sensor group comprising a selected set of the plurality of sensors; and

the main control circuit comprises guidance control circuitry adapted to receive data from the guidance control sensor group and to automatically operate the drive system in order to adjust the position of the downhole tool in accordance with a selected bore path.

8. The drilling system of claim 1 wherein:

the horizontal drilling machine further comprises a power system adapted to supply power to drive system;

the plurality of sensors comprises a power management sensor group comprising a selected set of the plurality of sensors; and

the main control circuit comprises power management circuitry adapted to receive data from the power management sensor group and to automatically operate the power system.

9. The drilling system of claim 1 wherein:  
the plurality of sensors comprises a tracking sensor group comprising a selected set of the plurality of sensors; and  
the main control circuit comprises tracking circuitry adapted to automatically detect the position of the downhole tool.
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10. The drilling system of claim 1 wherein:  
the plurality of sensors comprises a guidance control sensor group comprising a selected set of the plurality of sensors; and  
the main control circuit comprises guidance control circuitry adapted to receive data from the guidance control sensor group and to automatically operate the drive system while backreaming a borehole.
11. The drilling system of claim 1 wherein the main control circuit records the actual location of a product installed in a pilot borehole during a backream operation.

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12. A method for drilling a pilot borehole through the earth comprising:  
identifying a selected bore path having a beginning point and an ending point;  
automatically advancing a downhole tool along the selected bore path;  
automatically determining the position of the downhole tool relative to the  
selected bore path; and  
automatically guiding the downhole tool in response to the determined downhole  
tool position and the selected bore path.

13. The method of claim 12 wherein:

the beginning point is located above ground;  
the ending point is located above ground and remote from the beginning  
point; and  
the selected bore path is an underground path connecting the beginning  
point and the ending point.

14. The method of claim 12 further comprising:

automatically controlling a power system providing power necessary to  
advance the downhole tool along the selected bore path.

15. The method of claim 12 further comprising:

automatically providing drilling fluid to the downhole tool while  
advancing the downhole tool along the selected bore path.

16. The method of claim 12 further comprising:

automatically extending a drill string used to advance the downhole tool  
along the selected bore path.

17. The method of claim 12 further comprising:

recording the as-bored path of the borehole.

18. A method for installing a utility line in a borehole comprising:  
drilling a pilot borehole; and  
automatically backreaming the pilot borehole while installing a utility line.
19. The method of claim 18 further comprising attaching the utility line to a backreamer.
20. The method of claim 19 further comprising recording the actual location of the utility line installed underground as the utility line is automatically pulled through the borehole.

21. A horizontal drilling system comprising:

a horizontal drilling machine, comprising:

a drill string having a first end and a second end;

5 a drive system operatively connectable to the first end of the drill string  
and adapted to advance the drill string through the earth; and

a downhole tool connectable to the second end of the drill string; and

10 a machine control system adapted to automatically operate the drilling machine;  
wherein the machine control system is further adapted to receive data signals from  
a remote location, the data signals indicative of the depth and geographic  
location of the downhole tool; and

wherein the machine control system automatically operates the drilling machine  
in response to the data signals received.

22. In a surface to surface horizontal drilling operation, a method for advancing an underground tool from a first point to a second point, the method comprising:

identifying a selected bore path from the first point to the second point; and

guiding the underground tool along the selected bore path by automatically changing the direction of the underground tool.

23. A horizontal drilling system comprising:

a horizontal drilling machine having a plurality of automated functions and further comprising:

a drill string having a first end and a second end;

a drive system operatively connectable to the first end of the drill string

and adapted to axially move the drill string through the earth; and

a underground tool connectable to the second end of the drill string; and

a machine control system comprising:

a plurality of sensors, each sensor adapted to detect data relating to at least one parameter characteristic of the operation or environment of the drilling machine, and

a main control circuit adapted to receive data from the plurality of sensors and to automatically operate the automated functions of the drilling machine in response to this data.

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~~24. A method for using a horizontal drilling machine having a plurality of~~

automated functions, the machine comprising a drill string to which an underground tool is attached, the method comprising:

selecting a path along which the underground tool is to be used; and

5 axially advancing the drill string so as to move the underground tool along at least  
a portion of the selected path, while automatically operating the automated  
functions of the drilling machine.

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25. A horizontal drilling system comprising:

a horizontal drilling machine having a plurality of automated functions, and further comprising:

a drill string, having a first end and a second end;

a drive system operatively connectable to the first end of the drill string and adapted to advance the drill string through the earth;

a downhole tool connectable to the second end of the drill string;

a pipe handling assembly adapted to extend and reduce the length of the drill string;

a fluid dispensing assembly adapted to deliver fluid to the downhole tool;

a machine control system, comprising:

a plurality of sensors, each sensor adapted to detect data relating to at least one parameter characteristic of the operation or environment of the drilling machine; and

a main control circuit adapted to receive data from the plurality of sensors and to automatically operate at least two of the automated functions of the drilling machine in response to this data;

wherein at least one of the plurality of automated functions is selected from the group comprising a pipe handling function, a power management function, a guidance control function, a fluid control function, and a tracking function.

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